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**CORRESPONDENCE OF CLAIMS FOR ENTRY INTO
NATION PHASE IN USA
AND CLAIMS AS APPENDED TO IPER**

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CLAIMS

1. An apparatus for controlling the flow of a gas mixture of variable proportions, the apparatus comprising

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a conduit for the flow of gas;

a delivery means for delivery to the conduit of a gas mixture having gaseous components in controlled variable proportions;

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a regulator for regulating the flow of gas through the conduit;

a driver for operating the regulator;

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a setpoint signal generator for generating a setpoint signal according to a desired setpoint;

a volumetric flow meter situated downstream of the regulator for determining a volumetric flow rate of gas independently of the composition of the flow of gas;

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a feedback signal generator associated with the volumetric flow meter, said feedback signal corresponding to the flow rate measured by the volumetric flow meter; and

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an adjustment signal generator for generating an adjustment signal for controlling the driver by which the regulator is operated to open or close by an amount corresponding to the adjustment signal to achieve a desired flow rate corresponding to the desired setpoint, which adjustment signal generator comprises a comparator for comparing the setpoint signal and the feedback signal.

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2. An apparatus for correcting the flow of a gas mixture of variable proportions through a conduit, which flow is

regulated by a regulator operated by a driver in response to a setpoint signal generated, from a desired setpoint corresponding to a desired gas flow rate, by a setpoint signal generator which is connected to said driver, said
5 apparatus comprising an apparatus according to claim 1; and

a comparator for generating an adjustment signal for correcting the rate of flow,

10 wherein the setpoint signal generator is connected to the driver via the comparator in which the setpoint signal is compared with the feedback signal and the setpoint is corrected by reference to the feedback signal to produce an adjustment signal for transmission to the driver to adjust
15 the regulator to cause a change in the rate of flow of gas therethrough thereby reducing any discrepancy between the desired gas flow rate and the measured gas flow rate.

3. Apparatus according to claim 1, further comprising a
20 gas mixture which is a gaseous composition comprising variable amounts of at least two gaseous components having different molar specific heat capacities.

4. Apparatus according to claim 3, wherein the gaseous
25 composition comprises xenon in admixture with oxygen and/or nitrogen.

5. Apparatus according to claim 1, wherein the volumetric flow meter is one of a turbine wheel flow meter, a positive
30 displacement meter, a near-positive displacement meter, a vortex shedding meter, a swirl plate turbine meter and a correlation flow meter.

6. Apparatus according to claim 1, wherein the setpoint
35 signal generator comprises a potentiometer upon which may be set the desired setpoint corresponding to a desired flow rate through the conduit.

7. Apparatus according to claim 1, wherein the setpoint
signal generator comprises a slowdown circuit such that the
setpoint signal increases or decreases over time until the
5 setpoint signal corresponding with the desired setpoint is
reached.

8. Apparatus for providing and circulating a gaseous
composition to a medical device, said apparatus
10 comprising:-

a main circuit for recirculatory flow of gas to and
from said medical device;

15 a gas source for providing gas to the main circuit;
and

an apparatus for controlling the flow of gas according
to claim 1, for controlling the flow of gas to the medical
20 device and/or from the gas source to the main circuit.

9. Apparatus according to claim 8, wherein the gaseous
composition comprises a first gas and a second gas and the
main circuit comprises a circulation pump for pumping gas
25 through the circuit to supply the medical device with a gas
composition comprising a first gas and a second gas,

a gas outlet for connection to the medical device to
supply gas thereto,

30 a gas inlet for connection to the medical device to
receive spent gas therefrom,

a first supply conduit for supply of gas of a first
composition from a first gas source to the circuit,

a second supply conduit for supply of gas of a second
composition different from said first composition from a
35 second gas source to the circuit,

a first supply flow controller for controlling the
flow of gas through the first supply conduit, and

a second supply flow controller for controlling the flow of gas through the second supply conduit;

and which apparatus further comprises

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a concentration determiner for determining the concentration of at least one gas in the gaseous composition within the circuit; and

10

a vent for venting gas from the circuit.

10. Apparatus according to claim 9, which further comprises a bypass circuit, which permits at least a portion of the recirculating gas to bypass the gas outlet and the gas inlet, a gas outlet flow controller for controlling the flow of gas through the gas outlet and a pressure maintainer for maintaining the pressure to the gas outlet by controlling the flow of gas through the bypass conduit whereby flow of gas through the bypass conduit is prevented unless a predetermined pressure is attained.

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11. Apparatus according to claim 9 comprising

a first circuit gas concentration controller, including the first supply flow controller, for controlling the concentration of the first gas in the gaseous composition, which first circuit gas concentration controller comprises a first gas concentration determiner for determining the concentration of the first gas in the gaseous composition and communicating with the first supply flow controller for controlling flow of the first gas through the first supply conduit; and

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a second circuit gas concentration controller, including the second supply flow controller, for controlling the concentration of the second gas in the gaseous composition, which second circuit gas concentration

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controller comprises a second gas concentration determiner for determining the concentration of the second gas in the gaseous composition and communicating with the second supply flow controller for controlling flow of the second
5 gas through the second supply conduit,

whereby on reaching a respective predetermined level, each of said determiners triggers the corresponding flow controller to increase the flow of the corresponding gas to
10 the circuit.

12. Apparatus according to claim 11, wherein the first circuit gas concentration controller comprises a first gas concentration determiner for determining the concentration
15 of the first gas in the gaseous composition and communicating with the first supply flow controller for controlling flow of the first gas through the first supply conduit and the second circuit gas concentration controller comprises a monitor for monitoring the relative increases
20 and decreases in gas volume in the circuit and communicating with the second supply flow controller for controlling flow of the second gas through the second supply conduit, whereby on reaching a respective predetermined level, each of said determiners and said
25 monitor triggers the corresponding flow controller to increase the flow of the corresponding gas to the circuit.

13. Apparatus according to claim 12, wherein the first circuit gas concentration controller comprises a relatively
30 high gain analog electrical circuit and the second circuit gas concentration controller comprises a relatively low gain analog electrical circuit, whereby the increase in flow rate of the first gas is relatively quick and the increase in flow rate of the second gas is relatively slow.

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14. Apparatus according to claim 8, which further comprises an ultrasonic xenon analyser.

15. Apparatus comprising:-

a medical device requiring a supply of a gaseous
5 composition comprising a first gas and a second gas;

a main circuit for recirculating gas through the
medical device and comprising:-

a circulation pump for pumping gas through the
10 main circuit,
a gas outlet connected to the medical device,
a gas inlet connected to the medical device,
a first supply conduit for supply of gas of a
first composition to the main circuit,
15 a second supply conduit for supply of gas of a
second composition different from said first
composition to the main circuit,
a gas outlet flow controller for controlling the
flow of gas to the medical device;
20 a first supply flow controller for controlling
the flow of gas through the first supply conduit; and
a second supply flow controller for controlling
the flow of gas through the second supply conduit;

25 a concentration determiner for determining the
concentration of at least one gas of the gaseous
composition within the main circuit; and

a vent for venting gas from the main circuit,
30

wherein at least one of the gas outlet flow controller, the
first supply flow controller and the second supply flow
controller comprises apparatus according to claim 1.

35 16. Apparatus according to claim 15, which further
comprises:-

a first circuit gas concentration controller,
including the first supply flow controller, for controlling
the concentration of the first gas in the gaseous
composition, which first circuit gas concentration
5 controller comprises a first gas concentration determiner
for determining the concentration of the first gas in the
gaseous composition and communicating with the first supply
flow controller for controlling flow of the first gas
through the first supply conduit; and

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a second circuit gas concentration controller,
including the second supply flow controller, for
controlling the concentration of the second gas in the
gaseous composition, which second circuit gas concentration
15 controller comprises a second gas concentration determiner
for determining the concentration of the second gas in the
gaseous composition and communicating with the second
supply flow controller for controlling flow of the second
gas through the second supply conduit,

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whereby on reaching a respective predetermined level, each
of said determiners triggers the corresponding flow
controller to increase the flow of the corresponding gas to
the circuit.

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17. Apparatus according to claim 16, wherein the first
circuit gas concentration controller comprises a first gas
concentration determiner for determining the concentration
of the first gas in the gaseous composition and
30 communicating with the first supply flow controller for
controlling flow of the first gas through the first supply
conduit and the second circuit gas concentration controller
comprises a monitor for monitoring the relative increases
and decreases in gas volume in the circuit and
35 communicating with the second supply flow controller for
controlling flow of the second gas through the second
supply conduit, whereby on reaching a respective

predetermined level, each of said determiner and said monitor triggers the corresponding flow controller to increase the flow of the corresponding gas to the circuit.

5 18. Apparatus according to claim 16, wherein the first circuit gas concentration controller comprises a relatively high gain analog electrical circuit and the second circuit gas concentration controller comprises a relatively low gain analog electrical circuit, whereby the increase in
10 flow rate of the first gas is relatively quick and the increase in flow rate of the second gas is relatively slow.

15 19. Apparatus according to claim 15, which further comprises an ultrasonic xenon analyser.

20 20. Apparatus according to claim 15, wherein the medical device is selected from a cardiopulmonary bypass oxygenator and an artificial ventilator.

21. Apparatus according to claim 20, wherein the medical device is a cardiopulmonary bypass oxygenator.

22. Apparatus according to Claim 21, which apparatus further comprises one or more of a carbon dioxide absorber,
25 a carbon dioxide analyser and a pressure relief device downstream from the oxygenator.

23. A method of controlling the flow of a gas mixture of variable proportions through a conduit having a regulator
30 located therein against which is provided a known pressure of the gas mixture, said method comprising:

adjusting a setpoint on a potentiometer to a desired setpoint from a previous setpoint, which potentiometer is
35 connected to a driver for operating the regulator, said desired setpoint corresponding to a desired flow of fluid through the conduit as controlled by the regulator;

generating a setpoint signal from the adjusted desired setpoint on the potentiometer;

5 measuring the rate of flow of fluid passing through the conduit using a volumetric flow meter downstream from the regulator, the volumetric flow meter being capable of measuring the rate of flow of gas independently of the composition of the gas;

10 generating a feedback signal from the volumetric flow meter;

15 comparing the feedback signal with the setpoint signal;

generating an adjustment signal corresponding to the discrepancy between the setpoint signal and the feedback signal; and,

20 adjusting the regulator, using the driver, by an amount corresponding to the adjustment signal.

24. A method according to claim 23, which further
25 comprises increasing or decreasing the setpoint signal over a time period and by an amount corresponding to the difference between the desired setpoint and the previous setpoint.

30 25. A method according to claim 24, wherein increase or decrease in the setpoint signal over a time period is effected by providing a means of automatically adjusting the setpoint signal over the time period in response to a desired setpoint.

35 26. A method according to claim 24, in which the time delay compensates for a response time of the volumetric

flow meter such that the rate of flow of fluid through the conduit is relatively smoothly adjusted from a rate corresponding to the previous setpoint to a rate corresponding to the desired setpoint.

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27. A method of providing a medical device with a gaseous composition comprising a first gas and a second gas in controlled variable proportions, said method comprising:-

10 controlling the flow of a gaseous composition of a desired composition through a conduit leading to the medical device in accordance with the method of claim 22, collecting spent gas mixture from the device;

15 determining the concentration of each of the components of the gaseous composition remaining in the spent gas mixture;

 processing the spent gas mixture to remove unwanted
20 components;

 replenishing components in the spent gas mixture in response to the concentration determination to regenerate said desired composition; and

25

 recirculating resultant gaseous composition to the medical device.

28. A method according to claim 27, which further comprises
30 providing means of automatically increasing or decreasing the setpoint signal over a time period and by an amount corresponding to the difference between the desired setpoint and the previous setpoint, which time period is of an amount to compensate for the delay in generating a
35 feedback signal from the volumetric flow meter which accurately reflects the real-time volume of gas passing

through the conduit, which delay is caused by the response time of the volumetric flow meter.

29. A method according to claim 28, wherein the means of
5 automatically adjusting the setpoint signal is a resistor and capacitor arrangement in which the resistor is arranged in series with the potentiometer and the capacitor is arranged in parallel with the potentiometer.

10 30. A method according to claim 27, which further comprises replenishing components in the spent gas mixture in response to the concentration determination to generate a new desired composition.

15 31. A method according to claim 30, which further comprises maintaining the pressure of the gaseous composition being fed into the medical device at a desired level by diverting a portion of the gaseous composition to bypass the medical device when the desired pressure is
20 exceeded.

32. A method according to claim 27, which further comprises removing and storing spent gas for subsequent recovery in response to the concentration of an active
25 component falling below a predetermined level or the concentration of an unwanted component exceeding a predetermined level.

33. A method according to claim 27, wherein the first gas
30 is oxygen and the second gas comprises xenon.

34. A method according to claim 33, wherein the second gas is a mixture of xenon and oxygen in the ratio of about 80% to about 20% by volume.

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35. A method for the extracorporeal treatment of blood by contacting blood with a recirculating gaseous composition

in a device provided with a gaseous composition using a method defined in claim 27.

36. Use of a volumetric flow meter to provide feedback
5 correction to a regulator in a flow control apparatus for
controlling the flow of a gas mixture of variable
proportions of gaseous components through a conduit the
volumetric flow meter being capable of determining a
volumetric flow rate of a gas independently of the
10 composition of the flow of gas.

37. A use according to claim 36, wherein the volumetric
flow meter is a turbine wheel flow meter.

15 38. A method of providing a medical device with a gaseous
composition comprising xenon and oxygen in controlled
variable proportions, said method comprising:-

controlling the flow of a gaseous composition of a
20 desired composition through a conduit leading to the
medical device, said conduit having a regulator located
therein which regulator, when closed is subject to a gas
pressure of at least a desired level, by

25 adjusting a setpoint on a potentiometer to a
desired setpoint from a previous setpoint, which
potentiometer is connected to a driver for operating
the regulator, said desired setpoint corresponding to
a desired flow of fluid through the conduit as
30 controlled by the regulator;

generating a setpoint signal from the adjusted
desired setpoint on the potentiometer;

35 measuring the rate of flow of fluid passing
through the conduit using a volumetric flow meter

downstream from the regulator independently of the composition of the flow of gas;

5 generating a feedback signal from the volumetric flow meter and using said feedback signal to control the regulator.

39. An apparatus for controlling the rate of flow of gas through a conduit, said apparatus comprising:

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 a flow regulator for regulating the rate of flow of gas through a conduit;

 a digital potentiometer for providing a controllable
15 output signal for controlling the flow regulator to provide a selected flow rate of gas;

 a first digital encoder, which is a rotary encoder, having an output for selectively increasing and decreasing
20 the resistance of the potentiometer; and

 at least one other digital encoder having an output for selectively increasing and decreasing the resistance of the potentiometer,

25

 the arrangement being such that the voltage of the output signal from the digital potentiometer can be selectively increased and decreased by independent manipulation of the first digital encoder and the at least
30 one other digital encoder thereby enabling independent control of the rate of flow of gas through the conduit from more than one location.